Space Weather Technical Forecast

Issued on Saturday, 22 June 2024 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-class flares (R1-R2 radio blackouts) expected. Chance of isolated X-flares (R3 radio blackouts). Chance of S1/Minor radiation storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with the peak flare C6.7 at 21/2350 UTC from a region beyond the southeastern limb. There are currently seven sunspot regions on the disc. The largest and most magnetically complex regions all currently lie in the western hemisphere. AR3712 (Fkc/Beta) remains the most sizeable of these, with numerous large and mature spots, but has seen its delta spot decay during the period. AR3713 (Ekc/Beta-Gamma-Delta) is the most magnetically complex and next largest region on the disc, retaining a number of mature spots and a notable delta configuration in the leading portion of the group. Slight areal growth was observed. AR3716 (Eac/Beta) simplified magnetically with the decay of the minor delta spot and reduced in penumbral extent. AR3719 (Dso/Beta) and AR3720 (Dsi/Beta), both in the southeast, presented as rather simple, bipolar groups with little change. New unipolar regions AR3721 and AR3722 rotated over the eastern horizon as mature, unipolar (Hsx/Alpha) groups, meanwhile AR3718 decayed from view.

A large filament lift-off from the northwest disc late on 21 Jun is likely to have resulted in a slow CME. Further imagery is required to determine if there is any Earth-directed component from this.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by ACE at L1, indicated declining fast wind influence from CH45/+, with speeds reducing from 450km/s (slightly elevated) to around 350km/s (normal background) at the end of the period. Density was below average throughout. Interplanetary Magnetic Field, Bt, was weak, below 6nT. The north-south component, Bz, varied weakly between +5/-4nT. Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES18 remained at background levels with no solar radiation storms occurring. High energy electron flux (greater than 2MeV) observed by GOES16 was predominantly moderate, reaching 630 pfu at 21/1800 UTC. The 24-hour fluence was below Active on a slight rising trend, reaching 2.35e7 integrated pfu at 21/2359 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Further M-flares are expected, with a chance of isolated X-class flares, most likely from AR3712 and AR3713.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast period, but with lower confidence than usual early in the period. A large filament lift-off from the northwest disc late on 21 Jun is awaiting further imagery to determine if there is any Earth-

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directed component. Background solar winds are expected to persist through much of, if not the entire forecast period. There is a chance of a fast wind enhancement from the large coronal hole in the northwest disc on Days 1 and 2 (22 and 23 Jun), however, significant connection to this feature is considered unlikely given its high-latitude location on the disc. Another minor coronal hole enhancement is possible, but unlikely on Days 3 and 4 (24 and 25 Jun).

Overall mainly Quiet to Unsettled geomagnetic activity is expected. There is a chance of isolated Active intervals, mainly on Days 1 and 2 (22 and 23 Jun), should there be any notable connection to the aforementioned large coronal hole.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background levels, but with a chance of exceeding the S1/Minor Storm threshold should any notable flares occur, predominantly from any of the three large spots in the western hemisphere. High energy electron flux is forecast to be at mainly moderate levels on Days 1 and 2 (22 and 23 Jun), before likely declining to become predominantly background later in the period. The associated 24-hour fluence is expected to remain well below the Active threshold.

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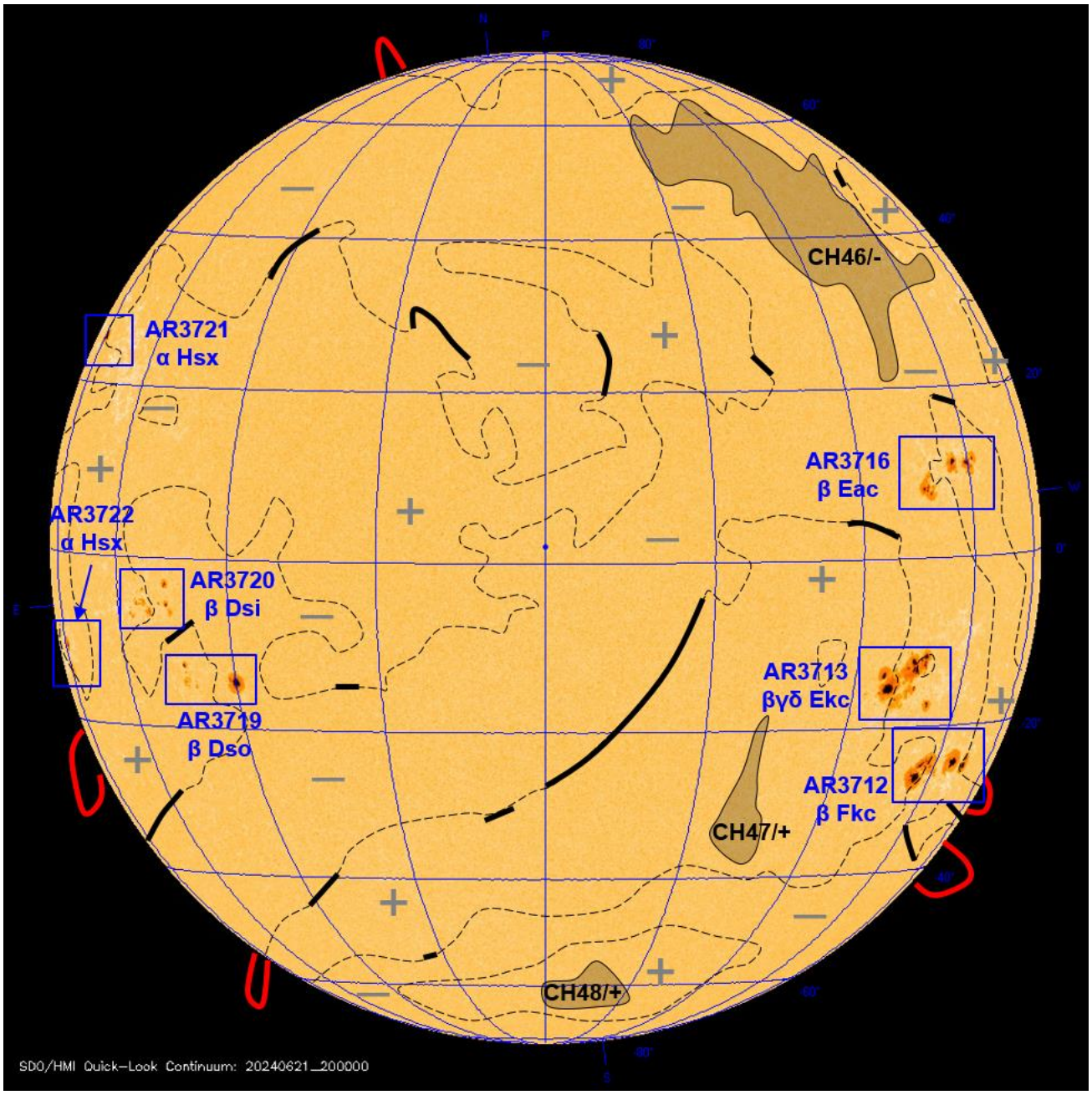
Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No obviously Earth directed CMEs are evident in imagery, however, given the number of CMEs in recent days there is some slight uncertainty in this aspect for the first couple of days of the forecast. A large filament eruption in the northwest disc late on 21 Jun is likely to have produced a CME, however, further LASCO imagery is required to determine if this feature is Earth-directed. Early assessment of coronagraph imagery indicates that the lift-off was not particularly energetic, nor strongly Earth-directed.

Solar winds are currently at normal background levels and speeds are likely to remain similar through much of, if not the entire forecast period. MOSWOC Enlil continues to indicate that a significant fast wind enhancement should already have occurred from large coronal hole, CH46/-, in the northwest disc. This feature is considered to be over-estimated in both strength and southern extent in Enlil. No significant enhancement was observed from this feature on the previous rotation, however, given the slightly more northward location of Earth above the ecliptic, there is a chance for a minor enhancement to be observed on Days 1 and 2 (22 and 23 Jun). In the unlikely case of any connection to this feature, wind speeds could potentially increase to slightly elevated, or perhaps elevated levels at peak, before easing later in the period. Either way, any geomagnetic response is expected to be limited at this time of year (around the solstice). Another minor coronal hole enhancement is possible from CH47/+ on Days 3 and 4 (24 and 25 Jun), but also thought to be unlikely, given its southerly latitude.

Overall mainly Quiet to Unsettled geomagnetic activity is expected. There is a chance of isolated Active intervals, mainly on Days 1 and 2 (22 and 23 Jun), should there be any notable connection to the high-speed stream enhancement from the aforementioned CH46/-.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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Radio Blackouts - X-Ray Flares:

There are currently seven sunspot regions on the disc. AR3712 (Fkc/Beta) in the southwest remains the largest region, but with limited change in the appearance and distribution of its numerous large spots. AR3713 (Ekc/Beta-Gamma-Delta) also in the southwest disc, evolves slowly, although retains a large delta region in the leading portion of the group. Some of the intermediate spots have developed stronger umbra in recent hours. AR3716 (Eac/Beta), located in the northwest, has seen its delta region decay, leaving a more simple magnetic configuration and also reduction in size of the main trailing spot. All three regions appear stable at this time, with limited flaring observed. AR3719 (Dso/Beta), in the southeast, continues to simplify as its main lead and trailer spots separate. AR3720 (Dsi/Beta), also in the southeast, is now showing more intermediate spots as it becomes more clearly visible, perhaps with some slight growth evident. There are two further regions rotating onto both the northeast and southeast limbs. These have been numbered AR3721 and AR3722 and present as unipolar regions, however, these may not yet be fully visible and their classification could change after further assessment.

AR3712 and AR3716 are due to rotate off the visible disc on Day 3 (24 Jun) and AR3713 on Day 4 (25 Jun), but will still pose a threat for significant flares just beyond the western horizon.

There are a number of potential returning regions in the period. Far-sided seismic data also indicates a larger region due to return on Day 3 (24 Jun) and is likely Ex-AR3664/Ex-AR3697, although may be significantly altered from when it was last on the visible disc earlier in June.

Further M-class flares are expected, with a chance of isolated X-class flares, most likely from AR3712 and AR3713.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	80	80	80	80
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 2: Latest GOES16/18 X-Ray Flux

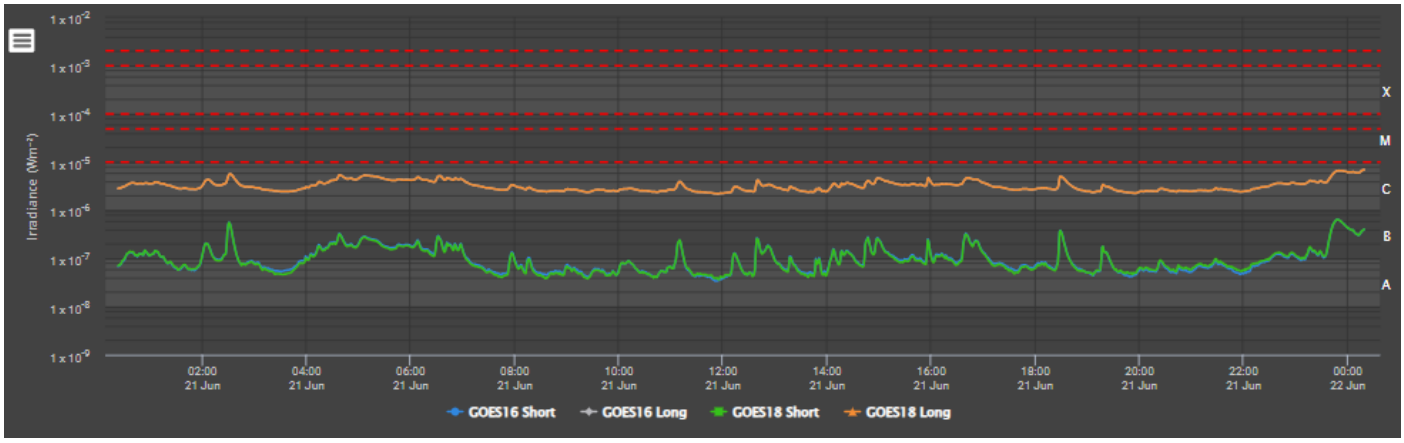

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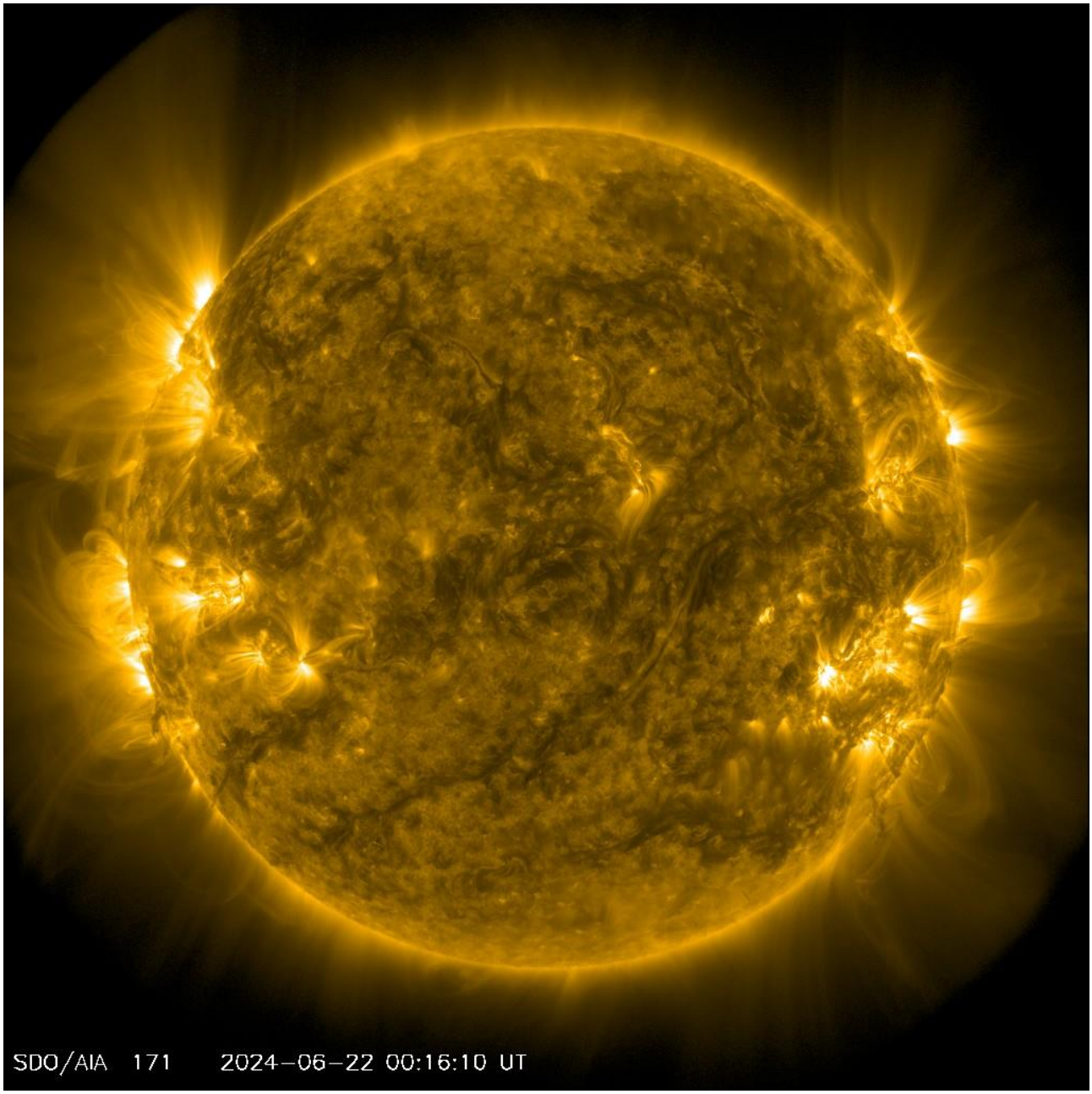
Figure 3: SDO/AIA 171 imagery at 22/0016 UTC. Notable magnetic looping close to the eastern limb suggests new sunspot regions soon to rotate onto visible disc.



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Solar Radiation Storms - (High Energy Protons):

GOES-18 proton flux remains at background levels, with no solar radiation storms observed. However, any significant flares, particularly from any of the three larger regions (AR3712, AR3713 or AR3716) in the western disc, have the potential to increase the observed flux and brings a chance of exceeding the S1 Minor Storm threshold.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	30	30	30
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, reached predominantly moderate levels as a consequence of the relaxation of the Van Allen belts following the fast wind enhancement from CH45/+. Electron flux is likely to continue at mainly moderate levels on days 1 and 2 (22 and 23 Jun), perhaps briefly reaching high levels at diurnal maxima, before declining later in the period to become mainly background. A more pronounced decline would be expected on days 1 and 2 should the potential connection to CH46/- occur.

Despite the recent increase, associated electron fluence is expected to persist well below the Active threshold (1e8 integrated pfu), with MOSWOC REFM output considered to be good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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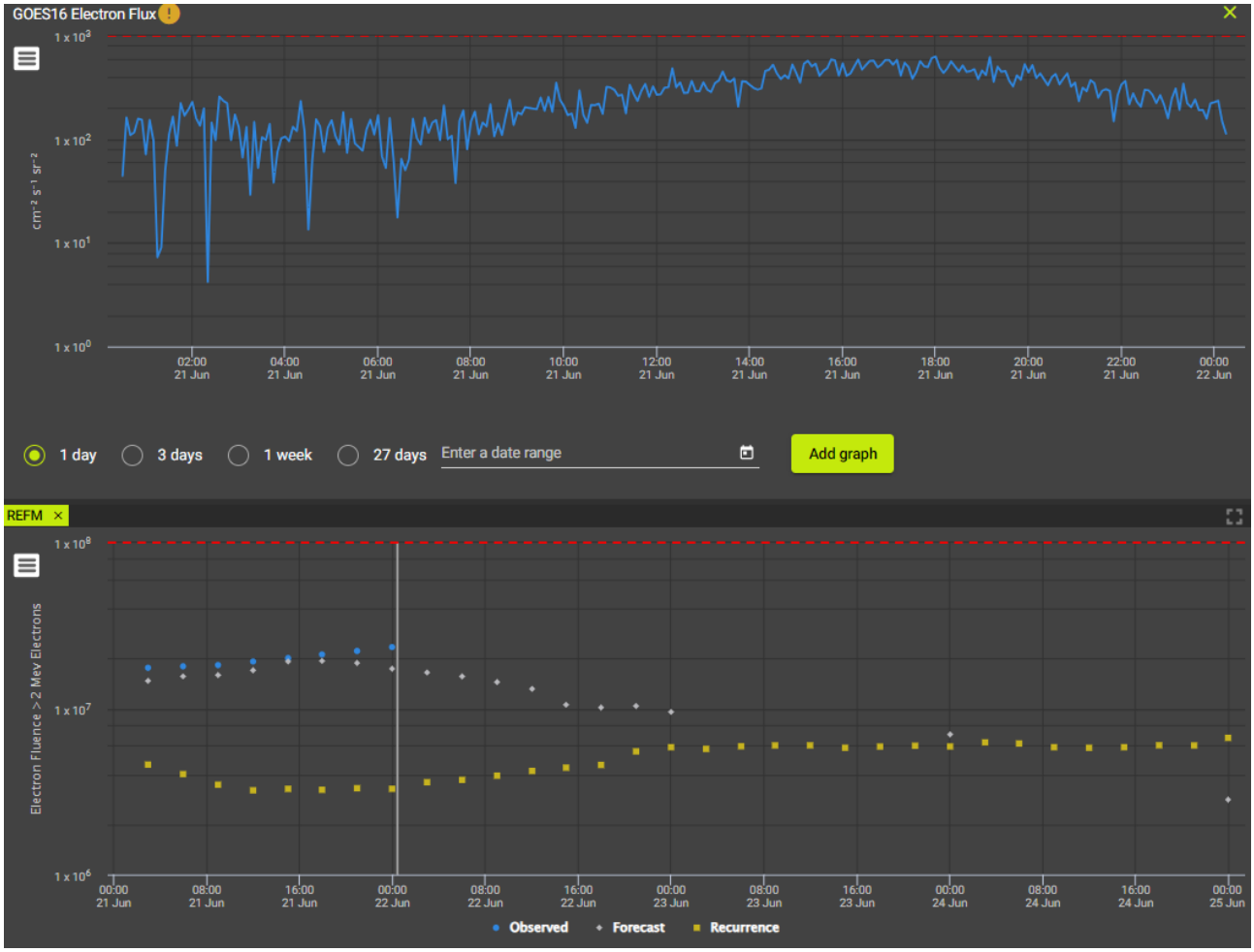
Figure 4: Latest GOES16 >2MeV Electron Flux (above) and MOSWOC REFM forecast with recurrence (below)



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